

in the shock of April 18, 1906, and the duration was much less but the motion was more violent.

Fortunately the telescopes and other instruments of the observatory suffered no injury, with the exception of the Riefler clock. The steel springs in the pendulum support of this clock were broken, allowing the pendulum to fall and break the airtight glass case. The 36-inch telescope was moved about three-quarters of an inch to the south, the great base plate slipping on the masonry pier. The telescope was put into position again promptly and without difficulty and has suffered no harm whatever.—*Prof. R. G. Aitken, Acting Director, Lick Observatory.*

NOTES ON THE RIVERS OF THE SACRAMENTO AND SAN JOAQUIN WATERSHEDS.

By N. R. TAYLOR, Local Forecaster.

SACRAMENTO WATERSHED.

There was a gradual diminution in the run-off of all streams in this watershed during the month, but all of the important watercourses carried more water than for any corresponding month during the past five years.

In the Sacramento River, above Red Bluff, there was only a slight range between the highest and lowest stages of the month, and in many of the reaches above Redding the river was practically stationary during the last half of the month. From Knights Landing, however, to the tide limits the difference between the stages of the 1st and those of the 31st of the month were more or less marked.

In the Feather-Yuba territory the rivers averaged from 2 to 2.5 feet higher than during the preceding July, and the Yuba River at Marysville was higher than in any July since 1907.

The American River averaged about 1 foot above the usual July stage and was the highest for any like month since 1907. It receded gradually from the 1st to the 31st with a range of 3 feet.

SAN JOAQUIN WATERSHED.

Except the Stanislaus, Mokelumne, and the San Joaquin, in the vicinity of Lathrop, all rivers in this watershed carried more water than for any July since the establishment of Weather Bureau gaging stations in the San Joaquin Valley. The San Joaquin in the vicinity of Firebaugh and Mendota continued above the flood stage until the 8th, but fell rapidly after this date and by the last of the month had fallen nearly 6 feet. Some lands in the vicinity of Mendota were flooded, but all interests were amply protected by the river forecasts from day to day.

PRECIPITATION AND ALTITUDE IN THE SIERRA.

By MR. CHARLES H. LEE.

NOTE.—This article is published by courtesy of the editor of the Journal of Electricity, Power, and Gas. Mr. Lee, as one of the engineering staff of the Los Angeles Aqueduct, has carried on extensive measurements of rainfall and depth of snow on the eastern side of the high Sierra, in Inyo County, in the watershed of the Owens River. Mr. Lee has been in touch with the Weather Bureau throughout the period covered by these measurements and has in every way tried to further its work.

Precipitation studies made by the Los Angeles Aqueduct officials in connection with a general investigation of water supply conditions in the Owens Valley have led to some interesting results regarding the relation of precipitation and altitude in the Sierra Nevada. The portion of the range considered extends from Lake Tahoe to the

Mojave Desert. Data gathered and published by the United States Weather Bureau were used where available and were supplemented on the east slope of the Sierra adjacent to the Owens Valley with records kept by the aqueduct officials. The investigations were carried on by the writer under the direction of William Mulholland, chief engineer of the Los Angeles Aqueduct.

The phenomenon of increase of precipitation with altitude is fully recognized by hydraulic engineers who have had occasion to investigate the subject of precipitation. As a basis for engineering computations the relation is often assumed to be a simple ratio, which may be applied without regard to any factor but difference of elevation. As a matter of fact, however, topography, prevailing winds, latitude, and conditions of the atmosphere have a marked effect upon the geographic distribution of rainfall as well as altitude. The straight line relation, even when used as a convenient approximation, has a limited use, and should not be employed indiscriminately, as is shown by the studies herewith presented.

The general area within which precipitation data were considered is shown by the accompanying map. Upon this are indicated the principal rivers and their drainage area, stream gaging and precipitation stations, and isohyets or lines of equal annual rainfall. The isohyets are those of the Water and Forest Association as amended in 1908 by Edwin Duryea, jr. The dotted isohyets in the southeastern portion of the area are revisions proposed by the writer, based on all data available to date. The southern and eastern extension of the 30-inch and 20-inch isohyets is the most radical change, and is justified by the aqueduct observations in Owens Valley.

The relations of precipitation and topography are shown in a general manner by the position of the isohyets. A more instructive method is by graphical study of observations made in and near cross sections of the Sierra, laid out at right angles to the trend of the range. Five such were chosen and are shown on the map as the Central Pacific, Mokelumne, Taboose, Oak, and Bairs sections. There are sufficient observations taken along the two most northerly of these to indicate the relations upon both slopes of the range, but records applying to the three southerly sections are confined to the east slope.

A list of stations along the Central Pacific and Mokelumne sections is given in Table 1, together with elevation, distance from the Great Valley, length of record, observed and computed mean seasonal precipitations, and observed precipitations during the season 1909–10. The stations selected were all within 12 miles of the sections, and their elevations were such that they lay in the average profile of ground surface. (See diagrams 3 and 6.) Of stations in the Central Pacific group, Sacramento, Newcastle, Iowa Hill, Reno (1888–89 to 1909–10) and Wadsworth (1890–91 to 1909–10) are maintained by the Weather Bureau. Observations at other stations are made by agents of the Southern Pacific Co. Stations in the Mokelumne group are all maintained by the Weather Bureau. Elevations are those published in Weather Bureau reports, and where possible were compared with those given on Government topographic sheets. Distances from the Great Valley were scaled from the Government topographic or from the general land office map of California. Observed mean seasonal precipitation was computed for the season, September 1 to August 31. The observed means are for periods of differing length, and to obtain values more strictly comparable the records were computed so as to apply to a single definite period. That selected for the Central Pacific group extended over the